

New Approaches to Using Remotely Sensed Data for Mapping Biophysical Variables

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Maps of biophysical variables are needed at many scales, from the field scale (for example, maps of fire risk) to the global scale (for example, maps of terrestrial biomass). In particular, biophysical variables concerning the quantity and distribution of vegetation amount are critical to many Earth Science studies. Current methods of predicting vegetation amount use remotely sensed images to provide a spatially exhaustive data source, and regression models and maximum-likelihood methods are typically used for producing maps from these images. Geostatistical approaches, which assume spatial dependence, have an untapped potential to map vegetation amount using information gained from images.

Two geostatistical methods, cokriging and conditional simulation, were contrasted with regression in terms of their accuracy and uncertainty description. For a synthetic data set constructed from imaging spectrometer data, regression was most accurate when ground and spectral variables were very closely related. Cokriging was more accurate in all other situations. Conditional simulation, though not as accurate, was superior to the other two methods in reproducing the univariate and spatial characteristics of vegetation amount. For a real data set from western Montana (USA), over 300 ground measurements of conifer canopy cover made in each of two years by the U.S. Forest Service and collocated spectral index (normalized difference vegetation index (NDVI)) values from Landsat TM were used to predict canopy cover in a 97-square-kilometer subarea. The nonlinear regression model between canopy cover and NDVI had statistically identical parameters in both years, but prediction intervals were very wide, and accuracy was low at test points. Cokriged maps had much higher accuracy, but were affected by the small sampling fraction and clumped distribution of ground measurements. Conditionally simulated realizations using collocated cokriging displayed the desirable aspects of cokriging and at the same time presented plausible global and spatial

distributions of canopy cover and were, therefore, considered preferable to the cokriged maps.

Related work was accomplished on a case study to test the implications of using inaccurate estimates of vegetation type derived from remote sensing for the results of deterministic ecosystem models. A conditional simulation method was used to model inaccuracy, and the results were fed into the Carnegie/Ames/Stanford Approach (CASA) terrestrial biomass model. The range of results faithfully straddled the true answer, while a result that did not incorporate inaccuracy of the image-derived maps was too low.

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Satellite Estimates of Terrestrial Biomass and the Effects of Deforestation on the Global Carbon Cycle

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Investigators of the Ecosystem Science and Technology Branch are generating new global model estimates for terrestrial biomass sources of atmospheric carbon dioxide (CO₂). This ecosystem simulation modeling uses a combination of global satellite observations, predictions of above-ground biomass based on climate and satellite vegetation indexes, and the most current data on country-by-country changes in global forest cover (1990 to 1995), which are compiled regularly by the Food and Agricultural Organization (FAO) of the United Nations. The model estimates for carbon fluxes, which include forest area regrowth and expansion of carbon sinks in temperate and boreal forest zones, are based on the most recent global maps for observed climate, elevation, soils, plant cover, and changes in forest areas from natural and human forces.